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Research Note

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LEARNING TO ESTIMATE STAND VOLUME FROM AERIAL PHOTOS

Karl E. Moessner, Research Forester
Division of Forest Economics and Recreation Research

ABSTRACT

Initial estimates of timber volume made by trainees in photo interpretation were compared with first estimates made by college students in forest mensuration classes. The experiment showed that estimating volume from aerial photographs can be taught as effectively as ground estimating, and in no more time.

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"How long would it take me to learn aerial photo estimating?"

Young foresters often ask this question, and it is a fair question deserving a straightforward answer--which is seldom given because it is not generally known.

Why do these young men ask it? Some may be idly curious, but many would like to learn an additional useful skill if given the opportunity. All have had classroom training and many have had some field experience in mensuration and volume estimating on the ground. But only a few have learned to make measurements directly on aerial photos, and still fewer have tried the technique of aerial estimating.

A further question is now being asked by many timber managers: Why aren't young foresters trained in photo estimating techniques as well as in traditional ones?

Two answers are readily apparent. First, the lack of skilled aerial photo interpreters makes few available either for forest employment or for giving training. And this very lack may create the impression that the necessary training is excessively long or difficult. Second, timber managers have accentuated the problem by not being willing to accept estimates of volume based on an optimum combination of photo and ground methods. This attitude prevails in spite of the increased efficiency possible in combined aerial photo-ground surveys, particularly when photo volume strata are used,[1] and in spite of the fact that double sampling techniques, which can result in substantial savings in survey costs, have been well documented.[2]

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[1] Society of American Foresters. Aerial photography. IN: Forestry Handbook 19: 25. 1955.

[2] Wilson, Richard C. Photo interpretation in forestry. IN: Manual of Photographic Interpretation. Pp. 484-489, illus. 1960.

The idea is widely held that a long training period is necessary for teaching a man to make adequately accurate estimates of timber volume from aerial photographs. However, so far as we could ascertain, no actual study had ever been made to determine any relation between length of time required for training and proficiency in estimating volumes from aerial photos. Accordingly, Intermountain Station set up and carried out a rather informal study, necessarily limited in scope, designed to compare the amount of training necessary to make comparably accurate photo and ground estimates of gross volume.

THE STUDY

Essentially this study compared 100 photo estimates made by trainees in short courses in photo interpretation with 300 ground estimates made by student foresters. Both groups were presumed to have had no training in estimating at the beginning of the study. The information to be gained from such small groups was admittedly limited but was adequate to permit study with these two objectives:

- To compare the variability of the mean average volume per acre from repeated aerial photo estimates with the variability of the mean average volume per acre from repeated ground estimates when both sets of estimates are made by beginners.

- To compare the variabilities described above with those obtained from first estimates by foresters who had learned to measure stand height and density from photos with acceptable precision, but who had received no previous training in estimating volume from aerial photos.

PROCEDURE

Photo estimates.--Two groups were given an identical training problem based on panchromatic photos. at 1:12,000-scale, of a 71-acre compartment in the Boise Basin Experimental Forest. One group was trainees taking 5-day short courses in photo interpretation. They had learned how to use their instruments but had had no previous training or experience in photo estimating. The second group was eight foresters who had achieved controlled precision in photo interpretation and measurement after about 2 months of on-the-job training.[3] All estimates by both groups were first attempts at volume estimating. No one in either group had ever visited the area estimated.

Each trainee received a stereogram with an overprinted dot grid having 51 regularly spaced dots within the compartment. Every fifth dot (11 in all) was marked for photo measurement. Trainees were instructed to classify the circular 1/5-acre surrounding each dot into one of four strata based upon height of dominant trees within the sample plot. At each of these 11 points the trainees measured and recorded average total height, crown diameter, and crown coverage of the dominant stand. From these measurements they read average per-acre volume from an aerial volume table and recorded it for each plot. Finally the mean volume for each classification was weighted by the number of plots so classified to compute a mean per-acre volume for the whole compartment. Admittedly the standard error of a mean from so few samples would be high; but since these trainees were expected to complete their estimates in about 4 hours, the number of measured plots had to be kept small.[4]

The volume estimated by each trainee was compared with the accepted gross board-foot volume for the compartment calculated from a 100-percent cruise of all trees 11 inches and larger d.b.h. The difference was used in computing the variability of repeated photo estimates.

Ground estimates.--We were unable to obtain ground estimates by students for the same tract for comparison. However, through the courtesy of forestry schools at four universities[5] we obtained 300 estimates by students from ground cruises made by classes in mensuration. These estimates, by 2- or 3-man crews, were made on 40- to 80-acre tracts and were predominantly 10-percent estimates based on 20 to 40 circular 1/5-acre plots. Species, d.b.h., merchantable height, and occasionally other features were measured or estimated. In a few cases, noncircular plots or strips or 20-percent cruises were used. Presumably, usual ground cruising procedures and volume tables were used by the students in converting field measurements to estimates of per-acre volume. Each student estimate listed the gross board-foot volume, which we compared with the accepted volume for the tract. Thus, the information was comparable to that submitted by the trainees in photo interpretation.

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[3] Moessner, Karl E. Graphic control charts--a possible aid in photogrammetric training. Photogrammetric Engin. 24: 643-650, illus. 1958.

[4] A skilled photo estimator probably would measure all 51 locations on this 71-acre tract and complete his estimate in less than 1 day.

[5] University of Washington, Montana State University, University of Michigan, and Purdue University.

Analysis.--The first step in the analyses of the photo and ground estimates was to compute the difference between the accepted volume for each tract and the students' or trainees' estimates. These differences were then reduced to percentages of the accepted volumes. This approach was necessary because the reported mean volumes ranged from 3,000 board feet per acre for eastern hardwoods to 100,000 board feet per acre for some west coast conifers. The variation of these percentages was fairly constant for all ground surveys regardless of their location or intensity. The proportion of the total number of estimates within a given percent of the accepted volume was then computed and used in comparing the results of photo estimating with those of ground estimating (table 1). The slight reduction in variability of estimates based on ground surveys might be attributed to the fact that the mean of the estimates was considered to be the true volume instead of volume estimated from a 100-percent cruise.

RESULTS AND DISCUSSION

This comparison of first attempts at volume estimation indicates that repeated photo estimates of total volume are nearly as precise as repeated ground estimates when both are made by inexperienced or only partially trained personnel. It also indicates that students can learn to estimate volume from aerial photos virtually as accurately as they now learn to estimate volume by ground measurements, and they can learn both in about the same length of training time. The study also shows that foresters who have acquired controlled precision in stereo measurement techniques can markedly improve the accuracy of their estimates with comparatively little increase in experience.

The typical student forester receives considerable training in use of the compass, tape, Abney level, and other ground mensurational tools before he tries to cruise timber. Rarely does he receive equal instruction in making basic photo measurements. This may account for some of the feeling that a long training period is necessary for teaching a forester to estimate volume accurately from photos. The usual graduate fresh from forestry school is not a proficient ground cruiser. Expert timber cruisers, whether they use ground measurements or photo techniques, have developed their superior skill through intensive training and experience. Added practice in photo measurement appears to produce as much increased skill in estimating as added experience in ground measurement.

Table 1.--Proportion of the total number of estimates within given percent of accepted true volume

Percentage difference from accepted volume	Photo estimates by 100 trainees taking 5-day short courses	Ground estimates by 300 students in mensuration classes	Photo estimates by 8 foresters with on-job training
	- - - - - - - - - - - - -	Percent of total number	- - - - - - - - - - - - -
Within 5	14.1	15.8	37.5
Within 10	31.3	34.2	50.0
Within 15	46.5	50.5	90.0
Within 25	64.6	72.9	
Within 50	92.0	94.3	
Within 75	99.0	98.2	
Within 100	100.0	100.0	

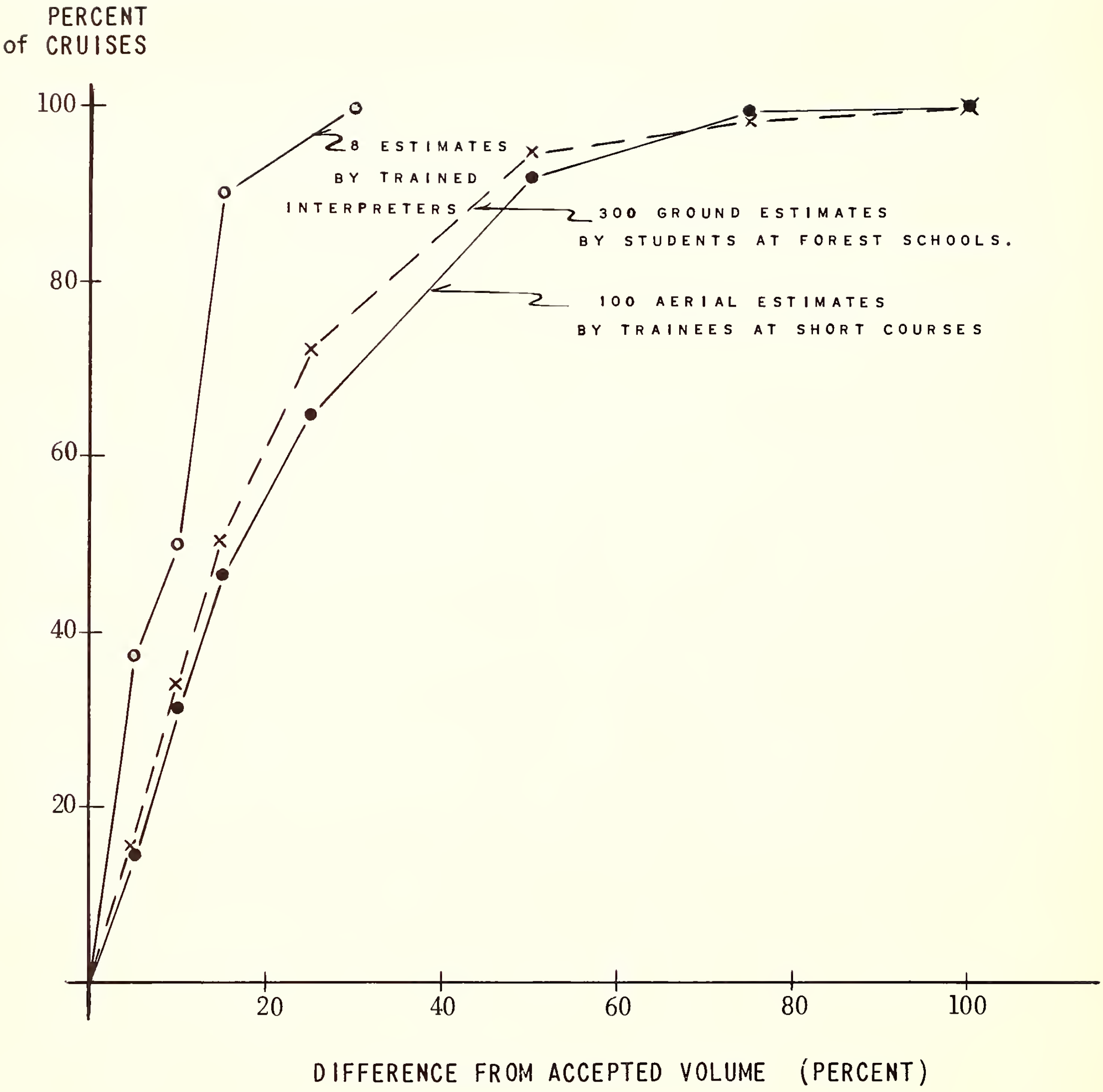

Figure 1.--Comparative precision of initial aerial and ground estimates of gross volume.

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